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Characteristics of sugar cane and eucalyptus production in the State of São Paulo

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The harvested area of sugar cane has increased significantly in the State of São Paulo recently. The ethanol made from sugarcane is used mainly for fuel, and the usage attracts a great deal of attention because it is considered as carbon-neutral, an environmentally friendly energy. Brazilian government enhanced ethanol production after the oil crisis in the 1970s, and regulated the production of ethanol, sugar and sugar cane. The production was liberalized in the 1990s, and Brazil became the leading country of the world in the production of ethanol and sugar. Especially, the export of sugar accounts for about 50% of the world's trade.

The impact on the environment is worried in the sugar cane production, because a considerable amount of chemical fertilizer is used in the cultivation, and the vinasse (vinhoto or vinhaça in Portuguese) that is a by-product of alcohol refinery also sprayed as fertilizer. The former may contaminate groundwater, and the latter may cause problems such as soil leaching and hardening. The progress of mechanization operated by heavy agricultural machinery also takes a risk of soil erosion.

The land-use sequences by means of sugar cane and eucalyptus production would present a way to solve the problems. Eucalyptus, growing swiftly, is used as the ideal material for paper pulp, firewood and construction. In particular, the production of paper pulp becomes the export industry of the country, and the plantation of eucalyptus is regarded as the profitable forestry.

The problems of eucalyptus production have also been pointed out. It absorbs a large quantity of water and soil nutrients to degrade the soil condition. However, a good use of the characteristics of eucalyptus may alleviate the environmental problems of sugar cane production. This study examines the possibility of the land-use sequences of sugar cane and eucalyptus by focusing on spatial analysis of maps and the data obtained from field survey.

Results: production structure of sugar cane and eucalyptus

(1) Production centers

The harvested area of sugar cane reaches 5.7 million ha by the Census of Agriculture 2006, and 54% of it is distributed in the State of São Paulo as shown in Fig. 1. The other leading states of sugar cane production are Alagoas (10%), Paraná (5.9) and Pernambuco (5.6). The production area of eucalyptus reaches 3.8 million ha, and the harvested area counts 284,716ha. It is distributed mainly in the Southeast (Sudeste) to the South (Sul) regions, i.e., the States of Minas Gerais (27%), São Paulo (20) and Rio Grande do Sul (15).

Though the State of São Paulo includes a large area of sugar cane and eucalyptus, the distributions differ by regions. In the scale of micro-region (microrregião), the harvest area of sugar cane is distributed largely in the north-central region of the state, i.e., Ribeirão Preto (380 thousand ha), São Joaquim da Barra (254), Jaú (199), Jaboticabal (193), Araraquara (188), Assis (183), and São José do Rio Preto (170). The harvested area of eucalyptus is distributed largely in the south-central region as it surrounds the production centers of sugar cane, i.e., Bauru (7360ha), Itapeva (4884), Avaré (4631), Piedade (3516), Batatais (3495), and Paraibuna e Paraitinga (3318).

(2) Production calendars

The harvest season of sugar cane continues from early April to late November in the State of São Paulo. The planting season of sugar cane varies from January to March, and June to November. The growing period is 18 months for the former planting and 12 months for the latter one. After the first harvest, sugar cane will be grown and cut four to five more times by ratooning. The period of ratooning varies around 12 months. After sugar cane, other crops such as soybeans, groundnuts, sweet potatoes, kidney beans and green manure are cultivated at once.

Sugar factories cultivate about 60% of the harvested area of sugar cane in Brazil. The factories manage farming divisions and own agricultural equipment, e.g., harvesters, tractors, planting machines. The yield of sugarcane reaches 70-150t/ha (90-110t/ha on average), and producers put considerable volume of chemical fertilizer (200-1500kg/ha). The quantity of fertilizer is no less than the production of maize and soybean. Nitrogen and potassium

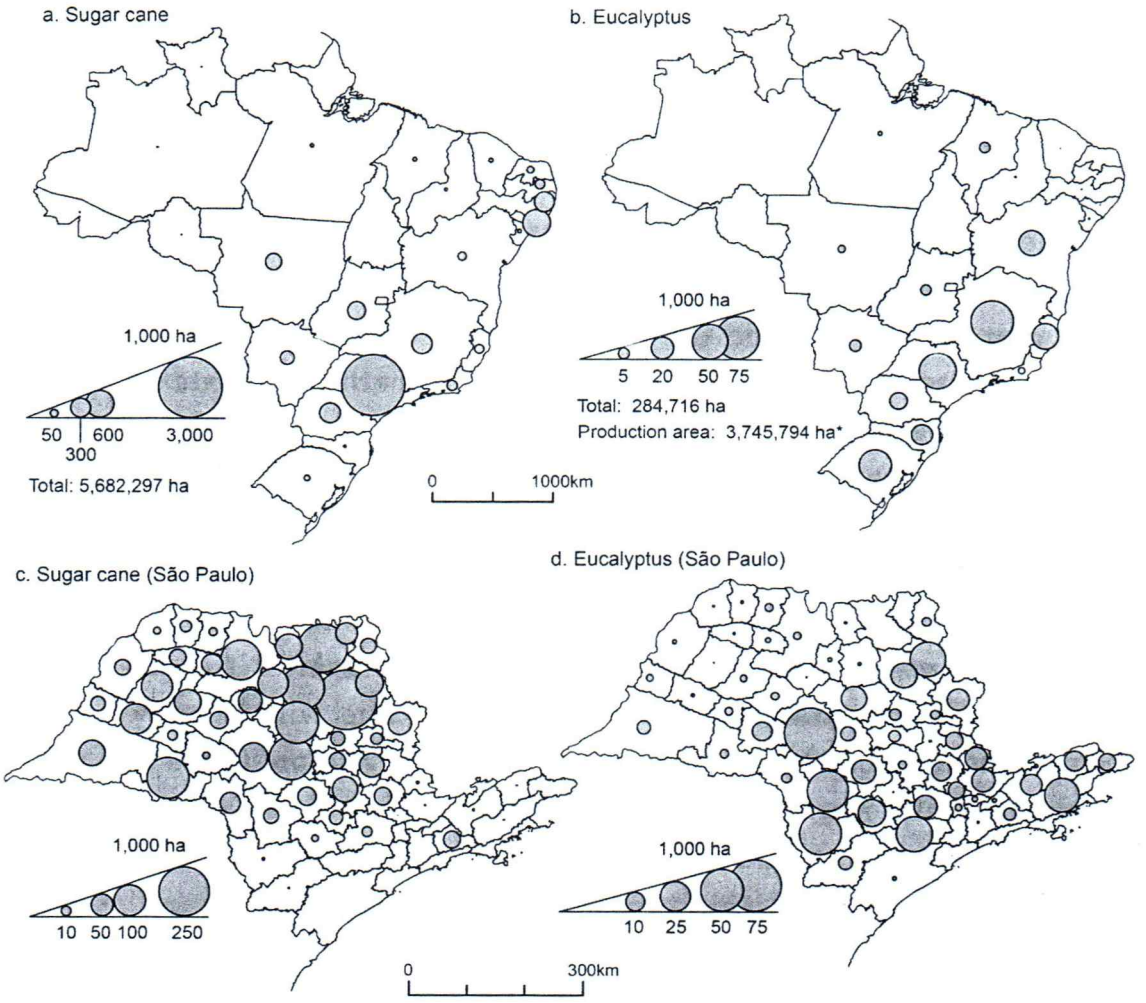

Fig 1. Harvested area of sugar cane and eucalyptus in Brazil, 2006

*Anuário Estatistica da ABRAF (Associação Brasileira de Produtores de Florestas Plantadas)
Source: Censo Agropecuário (IBGE: Instituto Brasileiro de Geografia e Estatística).

are the main compositions of the fertilizer. In the past when farms harvested sugar cane by hand cutting, they could cut more 10 times from a stump, though the yield was less than today.

The artificial forest of eucalyptus for pulp is cut in 7 years on average. At the year of cutting, the tree grows to 30-35m of height and 18-20cm of diameter. The young trees grown for 3-5 years, whose diameter reaches about 10cm, are sometimes cut for firewood and material to make fences. The production of eucalyptus reaches around 40m^3/ha/year including thinned wood. After cutting, producers will replant nursery plants after removing stumps. In case they return the forest to the landlords, they remove stumps and convert the land into grassland. The nurseries are planted in the

positions farthest from the old stumps. It is said that about 70% of the forestry (eucalyptus and pine) in Brazil is conducted by firms. By the case of our fieldwork, 75% of eucalyptus is cultivated by paper factory in the State of São Paulo.

(3) Cases of production

a. Sugar factory

The factory belongs to one of the major groups of sugar cane industry in Brazil. It gathers sugar cane from 40,000ha of arable land. Among them, 15,000ha is own land, 15,000ha is leased land, and 10,000ha is the land cultivated by suppliers (fornecedor). Sugar cane is basically cut 5 times from a stem, though the number differs depending on the condition of soil and climate. Among the sugar cane the company cultivates, 90% of is machine harvest, and 10% is manual harvest without burning. The factory possesses 22 combine harvesters, and gathers most of sugar cane within 28km from the processing plant. After the last harvest of sugar cane, the factory leases the land, and tenant producers cultivate soybeans or green manure such as crotalaria. The area of newly planting reaches 5000ha every year, and 60% of them are machine planting. Vinasse is sprayed in 12,000ha within 20km from the processing plant by the supply system with pipelines, tank lorries, ponds and pump huts. The quantity of the spray leaches 60-80m^3/ha for newly planting and ratooning. [Interviewed in September 2013]

b. Small farm of sugar cane

The farm produces sugar cane in 8.5ha of own land, and distills the spirit (cachaça) made from sugar cane. Sugar cane is cut 7-8 times from a stem on average. Depending on soil condition, the number of cut varies from 5 to more than 10 times. The growing period continues 12 months in newly planting, and 12 to 18 months for ratooning. The farm usually takes more than 14 months for ratooning to increase the yield. In the last cultivation of ratooning, the growing period is shortened to 12 months to produce another crop. The farm basically produces maize after sugar cane, however sometimes replants sugar cane. The managers of the farm are two brothers in their forties. Their father started sugar cane production in 1974. Before sugar cane, the farm produced maize, cotton and rice. Among the former crops, the income of maize was stable. [Interviewed in August 2011]

c. Paper factory

The factory runs 24 hours 7 days, and produces 360,000t/year of paper. The collecting area of eucalyptus reaches 100,000ha. It is distributed over 80km from the factory, extending to the State of Minas Gerais. The factory grows 74% of the area including 1500ha of leased land, and contract farms grow the rest. The factory owns 100,000ha of land, and grows 72,500ha of eucalypt, 4,100ha of reservation forest, and holds other land use such as bamboo forests. Eucalyptus is cut in 7 years. The area of felling reaches 11,000ha/year, about 1000ha/month. The factory produces about 1.3 million seedlings per month by tissue culture, and plants 1333 seedlings per hectare. A seedling occupies $8m^2$ in the field. Though many works such as plowing, harvesting and shipping are mechanized, considerable labors are need for planting. [Interviewed in August 2012]

d. Elderly farmer of eucalyptus

The farmer owns 100ha of land. Almost all of the land is artificial forest of eucalyptus for pulp. A paper factory manages the cultivation of eucalyptus. The farmer purchased the land in 1973, moved from Campinas in 1997, and produced oranges, potatoes and tomatoes. The owner started eucalyptus production in 2004. At the time, he decided to quit farming because he became 75 years' old, and his son managed horticulture in greenhouses adjacent to the main house. Until the year, agents from a paper factory came to negotiate with him for the production of eucalyptus by leased land. Other than the eucalyptus for pulp, the farmer keeps rows of eucalyptus. The trees are settled on the hilltop at the back of a lake. The "garden" eucalyptus were sometimes cut and sold for building material when the farmer needed money. [Interviewed in August 2012]

Discussion

Sugar cane and eucalyptus in Brazil are produced mainly by the factories and entrepreneurial farms that conduct large-scale management. They pursue economical productivity by adopting new technology such as mechanization, new varieties and innovative cultivation methods. As the result, the land use for sugar cane and eucalyptus production became much monotonous ones. The efficacy of leaching (lixiviation) by means of plantation of eucalyptus has been known for about 40 years, however, the land-use sequences including eucalyptus

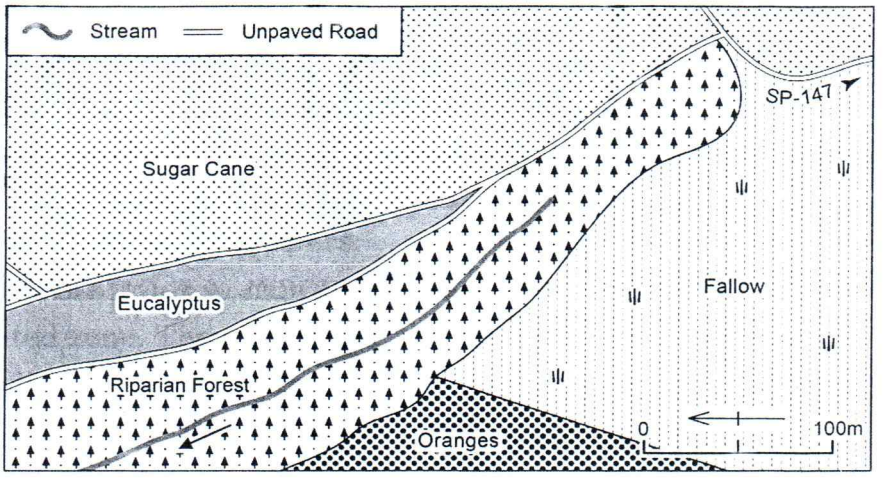

Fig 2. Case of land use in the west of Piracicaba, 2010
Source: Field survey.

have not been realized yet.

To find example of the land-use sequences, we observed a lot of landscape during our field survey, and also surveyed aerial photographs. It was hard to find out but we spotted a small example in the west part of Piracicaba as shown in Fig. 2. In the site, eucalyptus was elongated under the filed of sugar cane, and a valley extended in the lower place. Though detailed examinations in groundwater and geomorphology will be required, such a sequence would lead the environment-friendly land use because the eucalyptus will absorb the excessive fertilizers and flow of topsoil.

Conclusion

The production structure of sugar cane and eucalyptus is carried mainly by the large-scale and entrepreneurial management that follows the economical efficiency. Under the current conditions, it seems difficult to realize sustainable land-use sequences. In order to accomplish the land use in which eucalyptus is disposed under the field of sugar cane, small-scale management such as elderly farmers and part-time farmers will play an important role. As for political supports, eucalyptus of land-use sequences could be considered as a part of forest reserve by low.

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